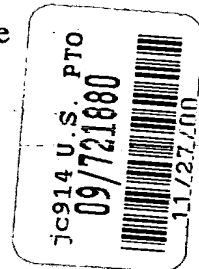




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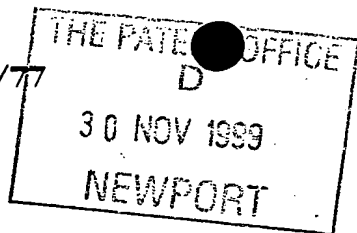
APPLICANT: James Reynolds HENSHAW, Peter Geoffrey HOLDEN,  
Richard John HOODLESS, Thomas Ian MACKINTOSH,  
and David Roberts MCMURTRY

APPLICATION NO.: New U.S. Application

FILED: November 27, 2000

FOR: MEASUREMENT APPARATUS INCLUDING A TRACK  
FOR A MEASUREMENT SCALE AND APPARATUS FOR  
TENSIONING THE SCALE

ATTORNEY DOCKET NO.: 107979



The  
Patent  
Office

30NOV99 E495242-1 D02651  
P01/7700 0.00-9928098.4

# Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road  
Newport  
Gwent NP9 1RH

30 NOV 1999

1. Your reference	456GB		
2. Patent application number (The Patent Office will fill in this part)	9928098.4		
3. Full name, address and postcode of the or of each applicant (underline all surnames)	Renishaw plc New Mills Wotton-under-Edge Gloucestershire GL12 8JR		
Patents ADP number (if you know it)	2691002		
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom		
4. Title of the invention	An Arrangement For Carrying A Scale For Use In Scale Reading Apparatus		
5. Name of your agent (if you have one)	J T Jackson et al		
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	Renishaw plc, Patent Department New Mills Wotton-under-Edge Gloucestershire, GL12 8JR United Kingdom		
Patents ADP number (if you know it)	6446298001		
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)
	-	-	-
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)	
	-	-	
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	Yes		

## Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form 0

Description 4

Claim(s) 0

Abstract 0

Drawing(s) 4

10. If you are also filing any of the following, state how many against each item.

Priority documents 0

Translations of priority documents 0

Statement of inventorship and right to grant of a patent (Patents Form 7/77) 0

Request for preliminary examination and search (Patents Form 9/77) 0

Request for substantive examination (Patents Form 10/77) 0

Any other documents (please specify) 0

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 29.11.99

AGENT FOR THE APPLICANT

12. Name and daytime telephone number of person to contact in the United Kingdom

A ILES 01453 524524

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**AN ARRANGEMENT FOR CARRYING A SCALE FOR**  
**USE IN SCALE READING APPARATUS**

5 The present invention relates to an arrangement for carrying a scale for use in scale reading apparatus.

10 A known form of opto-electronic scale reading apparatus for measuring relative displacement of two members comprises a length of scale on one of the members, having scale marks defining a periodic pattern, a read head provided on the other member, means for illuminating the length of scale, periodic diffraction means for  
interacting with light from the scale marks to produce interference fringes having movement relative to the read head and detecting means in the read head responsive to the fringes to produce a measure of the displacement.

15 An example of such apparatus is disclosed in EP-A-0 207 121 and also US-A-4,974,962. Typically, the length of scale could be of spring steel with a surface layer of copper. US-A-4,926,566 discloses a method of producing a length of scale, in the form of a flexible tape produced by rolling, the pitch of the scale marks being 20  $\mu\text{m}$  or 40  $\mu\text{m}$  for example.

20 The length of scale may be carried by being received by a track, for example comprising an aluminium extrusion, the lower part of the track being attached to a surface, for example by screws or bolts, and the upper part of the track being formed to receive the length of scale - see Fig. 1 which is a section through a length of track 1  
25 which is attached to a surface 2 by screws 3 spaced apart along its length and lengths of clamping strip 4, the upper part of the track 1 receiving a length of scale 5 which has been slid into it.

30 However, such an arrangement can be difficult to make and to install. The small ride-height tolerance of a typical read head means that the track can not be extruded to the required tolerance so it has to be machined after extrusion. Despite this there is still a significant loss of available ride-height tolerance because of machining tolerances and

the clearance required for the scale to slide within the track. In addition any unevenness in the surface means the track has to be shimmed.

5 According to the present invention, there is provided an arrangement comprising a length of track and a length of scale carried by the track and for use in scale reading apparatus in which the length of track is attached to a surface, wherein the length of scale is held magnetically by the track.

10 The length of track could hold a length of magnetic material (for example a length of flexible magnetic material such as ferrite rubber) for holding the length of scale magnetically. In this case, the length of magnetic material could be in a channel of the length of track, the length of scale being above the length of magnetic material, for example sitting on edge portions (which are, for example, below the upper surface of the track) along respective sides of the channel.

15 The length of track could be attached to the surface by screws passed through holes in it. Such holes could be at the bottom of such a channel or in the length of track alongside such a channel.

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20 The length of track could be an extrusion, for example an aluminium extrusion.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

25 Fig. 1 is a section through a known arrangement for carrying a length of scale by a length of track;

Fig. 2 is a plan view of a length of track for a first embodiment of the invention;

Fig. 3 is an enlarged view of part of the length of track of Fig. 2;

Fig. 4 is a section through the length of track and showing a screw through a hole in it;

30 Fig. 5 is a section through the length of track and showing a length of scale held on it;

Fig. 6 is a section through a wider form of track;

Fig. 7 shows a use of the wider form of track;

Fig. 8 is a plan view of a length of track for a further embodiment of the invention;

Fig. 9 is an enlarged view of part of the track of Fig. 8;

5 Fig. 10a) is a section through A-A of Fig. 9, Fig. 10b being an enlarged view of part of Fig. 10a); and

Fig. 11 shows means for fixing lengths of track end to end.

Referring to Figs. 2-5, a length of aluminium extrusion provides a length of track 6  
10 attachable to a surface by screws 7 passed through holes 8 spaced apart (for example with a pitch of 10cm) along the length of track 6. The length of track 6 is formed with a channel 9 running centrally along its length, the holes 8 being at the bottom of the channel 9. Also, along each side of the channel 9 is an edge portion 10 below the upper surface of the length of track 6.

15

With lengths of track 6 attached to a surface by screws 7, between each pair of holes 8 there is laid a strip 11 of flexible magnetic material, held on to the bottom of the channel 9 by a strip 12 of double-sided adhesive tape. By way of example, the strips 11 could be strips of ferrite rubber such as that provided by Magnet Applications  
20 Limited, of Northbridge Road, Berkhamsted, Hertfordshire HP4 1EH, England. Then, a length of scale 5 (for example for use in opto-electronic scale reading apparatus) is laid on to the edges 10 and held magnetically in place on the track 6 by the strips 11 of flexible magnetic material.

25 Fig. 6 shows a section through a wider length of track 6 for use in the arrangement of Fig. 7 in which a read head carried by a sprung read head carriage 13 runs on the length of track 6. A wheel 14 is fixed via a bracket to the read head carriage 13 and the assembly sprung towards the scale 5. The wheel runs on the length of track 6, maintaining the correct scale to read head gap substantially irrespective of undulations  
30 and steps in the surface to which the length of track 6 is attached.

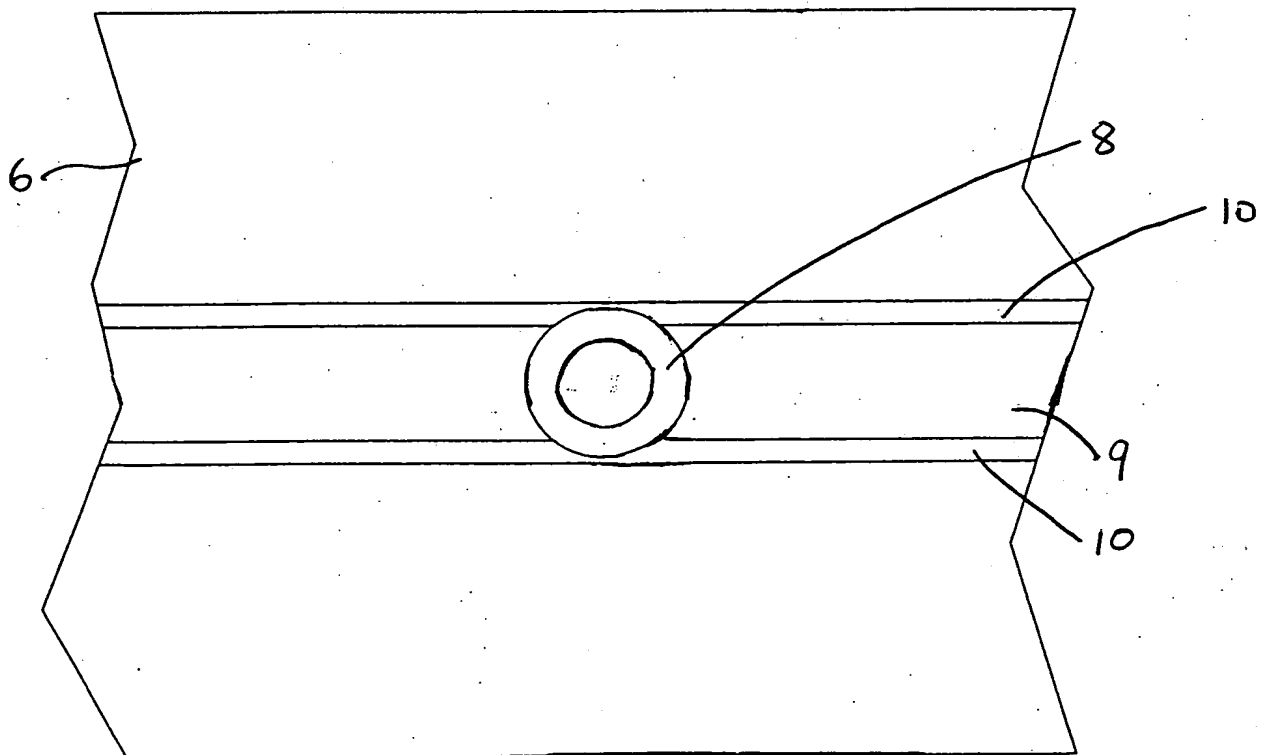
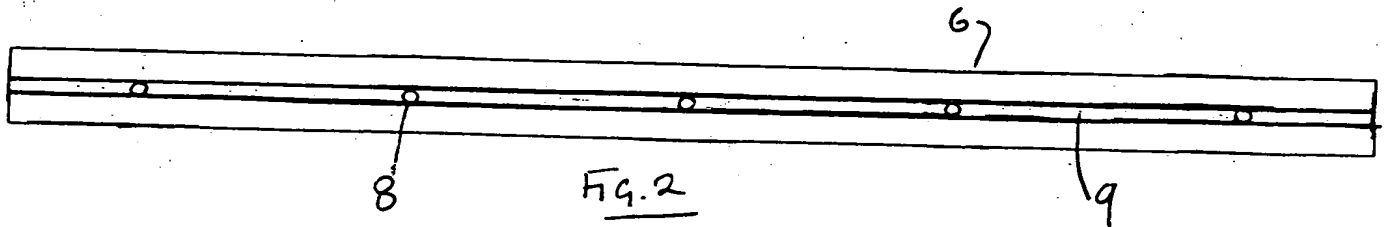
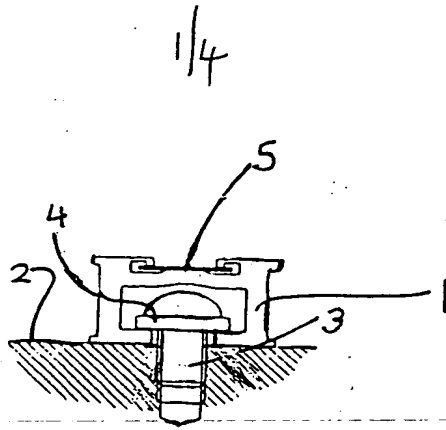
In the above embodiments, the length of track 6 is formed with a channel 9 running centrally. Referring to Figs. 8, 9, 10a) and 10b) an alternative form of length of track 6a comprises an aluminium extrusion formed with holes 8a spaced apart along its length for attaching the track 6a to a surface by screws, the holes being offset from the longitudinal centre line of the length of track 6a. Also offset from the centre line is a channel 9a along each side of which there is an edge 10a. In use, the length of track 6a is attached to a surface, a strip of flexible magnetic material is held on to the bottom of channel 9a by a strip of double-sided adhesive tape and a length of scale is laid on to the edges 10a and held magnetically in place by the strip of flexible magnetic material. Such a structure may be used, like with the Fig. 7 embodiment, with a sprung read head carriage to which a wheel is attached, the wheel running on the upper surface of the length of track 6 alongside the channel 9a.

Such lengths of track 6 or 6a may be placed end to end with a small (~0.5mm) clearance. This is satisfactory unless the surface to which they are attached is uneven. A solution is to make each end of such a length of track as shown in Fig. 11 so two ends plug together by virtue of dowels 15 and holes 16. In practice this could be achieved with two keyhole slots open at the bottom, a suitable dowel-pin being fixed in one of the holes. This enhancement would be particularly useful when used in conjunction with a sprung read head carriage.

In the above embodiments, the magnetic force holding the length of scale in place should not be greater than necessary since it is useful to minimise sliding frictional force between scale and track. This is achieved by the choice of air gap between the scale and the magnetic material.

It will be appreciated that the present invention may be used with scale other than for opto-electronic scale reading apparatus – for example scale reading apparatus which operates by magnetic or capacitive detection.







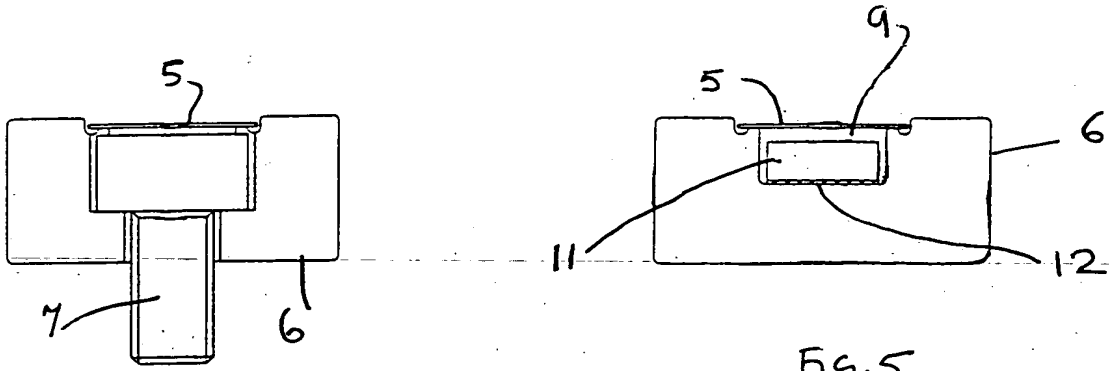


Fig. 4

Fig. 5

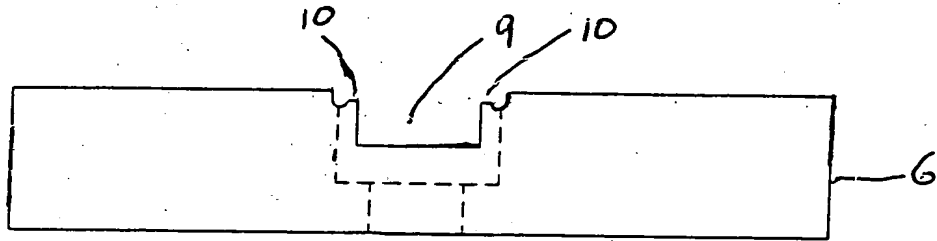


Fig. 6

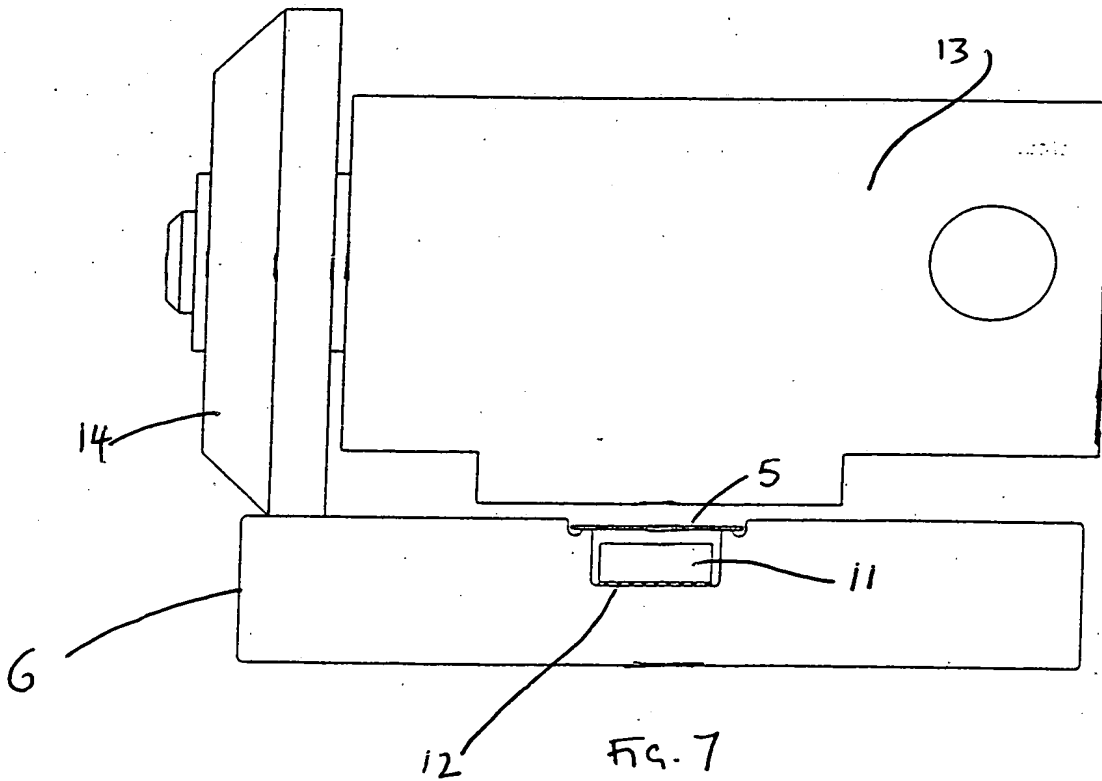
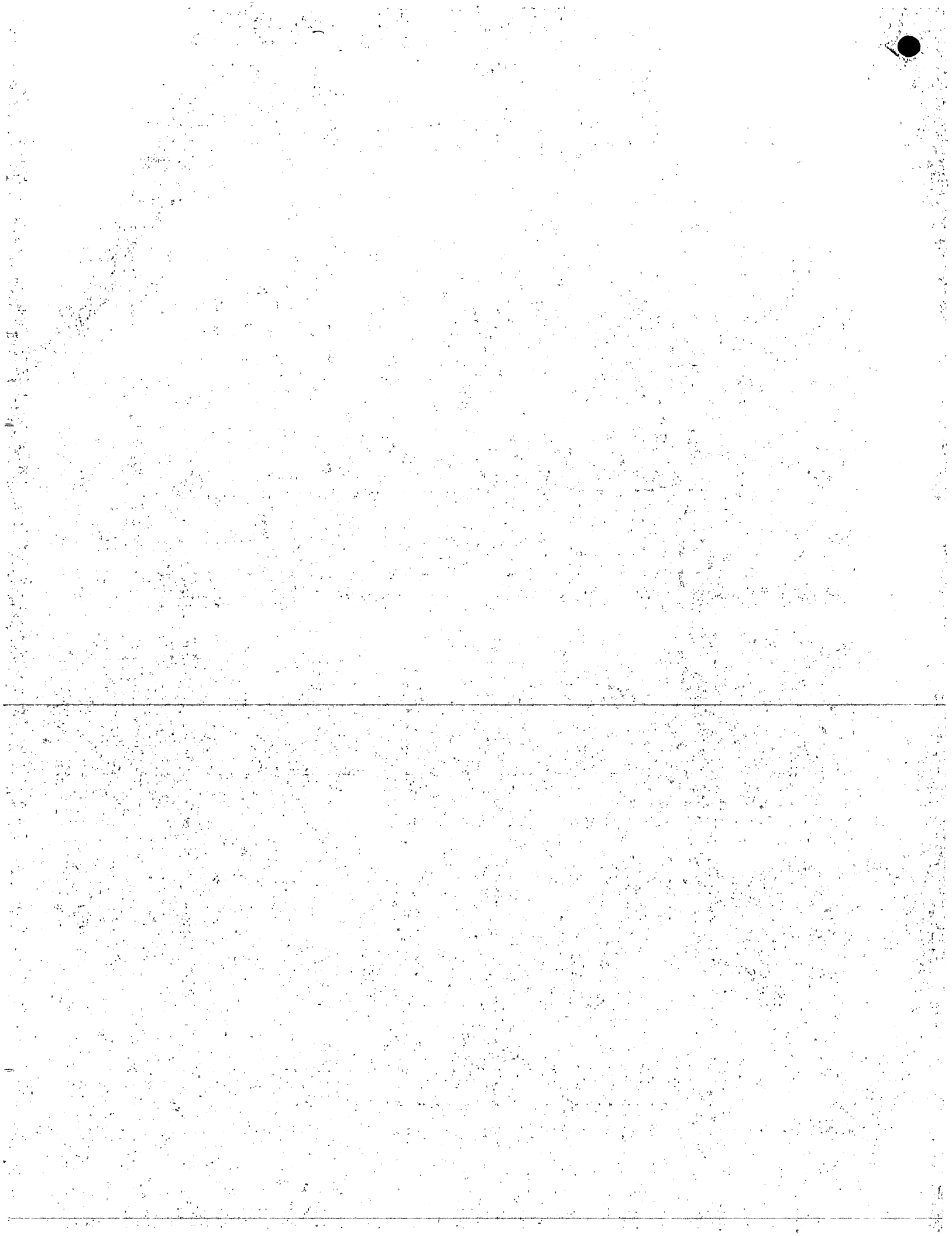


Fig. 7



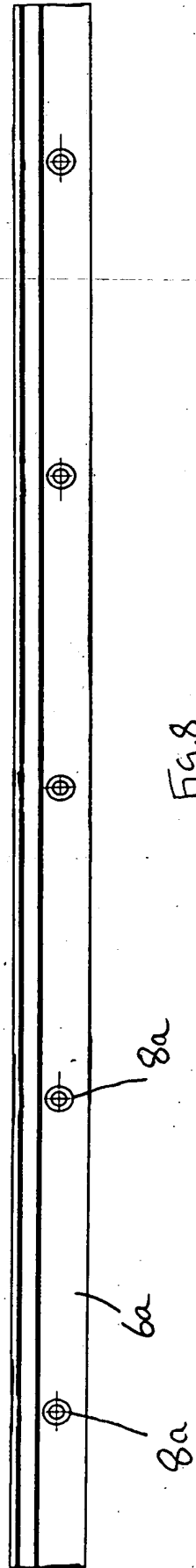


Fig. 8

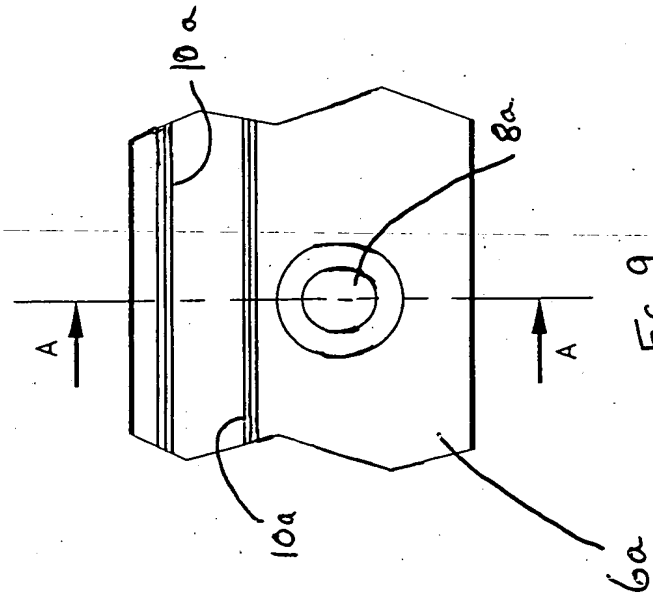


Fig. 9

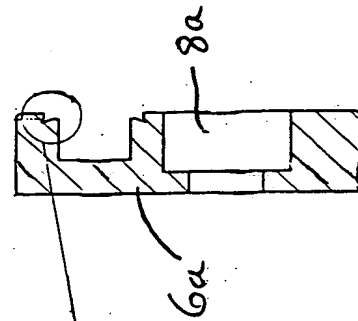


Fig. 10a)

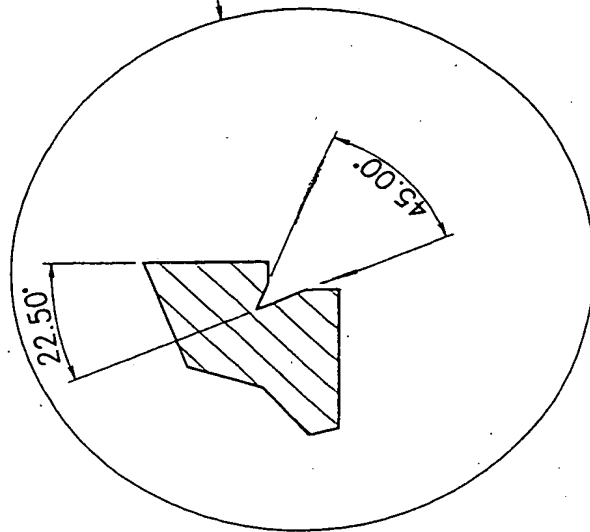


Fig. 10b)



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